

FIG. 11 is an elevational view of a propeller with three vanes uniformly distributed around the circumference of the hollow shaft;

FIGS. 12 and 13 are sectional views on lines XII—XII and XIII—XIII, respectively, in FIG. 11;

FIG. 14 is a view of a foam knife as seen in the axial direction of the hollow shaft, and

FIG. 15 is a sectional view on line XV—XV in FIG. 14.

The mixing device as shown in FIG. 1 dips down into a container for the liquid F to be treated. A stationary beam 1 supports a cardan 2 (i.e., a universal joint that transmits motion unchanged) in which the rotary mixing device is journaled so that it can be swung in all directions and be locked in any desired operating position.

The mixing device itself comprises a driving motor 3 with a lever 4 by which the motor can be swung on the joint 2. A hollow shaft 5 is rigidly connected to and driven by the motor 3. At its lower end, shaft 5 carries a propeller P immersed in the liquid F. Above the liquid level, shaft 5 has openings 6 for sucking in air, while the free lower end of the shaft has an axial outlet opening 7. Just above the liquid level, the hollow shaft 5 carries a foam knife 8 with radially extending arms which are preferably helical. A disc (not shown) can be provided on the hollow shaft as a splash guard below the air suction openings 6. The propeller P, fixed to the hollow shaft just above its axial outlet opening 7, consists in this simple case of two similar but diametrically opposed vanes 9 each making about one full pitch turn.

The four modifications of the propeller shown in FIGS. 3 through 6 are different geometrical fundamental shapes of two vanes displaced 180° in relation to each other on the shaft 5. According to FIG. 3, the two vanes 10 have constant radius and are slightly arched as a shovel along their outer edges 11. In the embodiments according to FIGS. 4 through 7, the radius of the two vanes 10a, 10b or 10c starts from practically zero at the upper ends of the vanes and continuously increases along the length of the vanes towards the opening 7 or 7a. While in the embodiments according to FIGS. 3, 4 and 7 only the outer edge 11 or 11a of the vanes is arched in such a manner that this outer edge forms an acute angle with the longitudinal axis of the hollow shaft, as seen from the free end of the shaft, the whole vane surface 10b or 10c in the embodiments according to FIGS. 5 and 6 forms in the same manner an acute angle. According to FIG. 5, the opening 7a of the lower end of the hollow shaft widens as a funnel and passes over to the outer edges 11b of the vanes 10b. FIG. 6 shows a modification of the propeller P, the vanes 10c of which extend a distance past the outlet opening 7 like fins 10d.

FIG. 7 illustrates an additional advantageous embodiment of the propeller P, in which the free end portion of the hollow shaft 5 (also here having an outlet opening 7a widening like a funnel) extends to an appreciable amount past the lower end of the vanes 10a. When the vanes have a correct shape, the water jet S flowing away in the axial direction from the propeller P has the form of narrowly bundled whirl plait with bulges and nodes like an oscillation figure. When the low end of the hollow shaft 5 extends past the ends of the vanes 10a by the amount of about half a so-called wavelength of this whirl jet S (thus past the first oscillation node and to a place within the second oscillation bulge), an optimum effect is obtained, namely a very intense

whirling-through of the water jet S with air in the form of very small bubbles and consequently a long holding time and a correspondingly great reach of the water jet S, enriched with oxygen.

In FIGS. 8 and 9 there is shown another suitable shape of the propeller P, in which an additional air outlet opening 13 is provided in the wall of the hollow shaft 5 at a place between the two vanes 12. This opening is shielded by means of a part 14 cut out from the wall of the shaft. Also in this embodiment, as in the example according to FIG. 7, an especially intense whirling-through of the water jet S with air is obtained.

FIG. 10 shows another embodiment of the outlet opening of the hollow shaft, in which the widened outlet opening 7b has a shape with two points and a longitudinal, S-shaped center line and partly passes over to the edges of the vanes 9.

FIG. 11 shows more in detail the arrangement of three vanes 15, 16 and 17 which are uniformly distributed around the circumference of the hollow shaft 5. The radius of these vanes is increased at the lower end of the hollow shaft, and the outer edge 18 of each vane is joined to the surface of an adjacent vane in such a manner as to form a rounded, concave surface 19 which faces away from the hollow space of the shaft and is situated radially outside the outer surface of the shaft. This prevents solids from sticking to the free end of the hollow shaft. Furthermore, the velocity of the axial liquid jet is accelerated.

FIGS. 12 and 13 show the shape of the vanes 15, 16 and 17 at different levels of the propeller, and FIG. 13 illustrates the rounded, concave surfaces 19.

FIG. 14 shows the shape of helically curved arms 20 fixed to the hollow shaft 5 to provide a foam knife 8. Their helical shape prevents sticking of solids when the hollow shaft rotates in the operating direction A.

FIG. 15 shows a cross-section of an arm 20, and the line L indicates the plane of rotation of the arms 20. This figure shows how the arms 20 are inclined so as to act as fan vanes. When the hollow shaft rotates in the operating direction, the arms suck foam from the foam layer above the surface of the liquid and beat it asunder.

I claim:

1. In combination with a body of liquid, a device for supplying gas to said liquid and revolving the liquid, said device comprising a hollow shaft for supplying gas to the liquid and having a free lower end portion provided with a gas outlet immersed in the liquid, means to supply gas to the hollow shaft, a propeller carried by said free end portion of the shaft, and means to drive said propeller for revolving the liquid said propeller including at least two screw-shaped vanes, at least a part of the surface of each vane forming an acute angle with the longitudinal axis of the hollow shaft, as seen from the free end of the shaft, each said vane extending along at least two thirds of the circumference of the hollow shaft, said vanes being uniformly distributed around the circumference of the hollow shaft, a surface of one said vane at the free end of the hollow shaft being joined at its outer edge to a surface of an adjacent vane to provide a rounded concave surface facing away from the hollow interior of the shaft, said concave surface being situated radially a distance outside the outer surface of said shaft.

2. The combination of claim 1, in which each said vane is arched in the direction toward the free end of the hollow shaft.